Claim Amendments

1. (original) A semiconductor modulator for modulating an optical wave with an RF signal, said modulator comprising:

a substrate;

an N-type layer deposited on the substrate;

a semiconductor intrinsic layer deposited on the substrate and in contact with the N-type layer, said intrinsic layer containing an optical waveguide, said intrinsic layer including first and second diffraction gratings positioned at opposing sides of the intrinsic layer;

a P-type layer deposited on the substrate and in contact with the intrinsic layer; and

a first electrode in electrical contact with the N-type layer and a second electrode in electrical contact with the P-type layer, said first and second electrodes receiving the RF signal and said first and second diffraction gratings slowing the optical wave to match its speed to the speed of the RF signal in the electrodes.

2. (original) A semiconductor modulator for modulating an optical wave with an RF signal, said modulator comprising:

a substrate;

an N-type layer deposited on the substrate;

a semiconductor intrinsic layer deposited on the substrate and in contact with the N-type layer, said intrinsic layer containing an optical waveguide, said intrinsic layer, including first and second diffraction gratings positioned at opposing sides of the intrinsic layer, said first and second diffraction gratings including etched holes in the intrinsic layer that extend in a direction perpendicular to the propagation direction of the optical wave;

a P-type layer deposited on the substrate and in contact with the intrinsic layer; and

a first electrode in electrical contact with the N-type layer and a second electrode in electrical contact with the P-type layer, said first and second electrodes receiving the RF signal and said first and second diffraction gratings slowing the optical wave to match its speed to the speed of the RF signal in the electrodes.

3. (previously presented) A semiconductor modulator for modulating an optical wave with an RF signal, said modulator comprising:

a substrate;

an N-type layer deposited on the substrate;

a semiconductor intrinsic layer deposited on the substrate and in contact with the N-type layer, said intrinsic layer containing an optical waveguide, said intrinsic layer including first and second Bragg diffraction gratings positioned at opposing sides of the intrinsic layer;

a P-type layer deposited on the substrate and in contact with the intrinsic layer; and

a first electrode in electrical contact with the N-type layer and a second electrode in electrical contact with the P-type layer, said first and second electrodes receiving the RF signal and said first and second diffraction gratings slowing the optical wave to match its speed to the speed of the RF signal in the electrodes.

4. (original) The modulator according to claim 1 wherein the first and second diffraction gratings are formed by a material different than the material of the intrinsic layer.

5. (original) The modulator according to claim 4 wherein the material different than the intrinsic layer is Quantum Dots.

6. (original) A semiconductor modulator for modulating an optical wave with an RF signal, said modulator comprising:

a substrate;

an N-type layer deposited on the substrate;

a semiconductor intrinsic layer deposited on the substrate and in contact with the N-type layer, said intrinsic layer containing an optical waveguide, said intrinsic layer including first and second two-dimensional diffraction gratings positioned at opposing sides of the intrinsic layer;

a P-type layer deposited on the substrate and in contact with the intrinsic layer; and

a first electrode in electrical contact with the N-type layer and a second electrode in electrical contact with the N-type layer, said first and second electrodes receiving the RF signal and said first and second diffraction gratings slowing the optical wave to match its speed to the speed of the RF signal in the electrodes.

7. (original) A semiconductor modulator for modulating an optical wave with an RF signal, said modulator comprising:

a substrate;

an N-type InP layer deposited on the substrate;

a semiconductor intrinsic InP layer deposited on the substrate and in contact with the N-type InP layer, said intrinsic InP layer containing an optical waveguide, said intrinsic InP layer including first and second diffraction gratings positioned at opposing sides of the intrinsic InP layer;

a P-type InP layer deposited on the substrate and in contact with the intrinsic InP layer; and

a first electrode in electrical contact with the N-type InP layer and a second electrode in electrical contact with the P-type InP layer, said first and second electrodes receiving the RF signal and said first and second diffraction gratings slowing the optical wave to match its speed to the speed of the RF signal in the electrodes.

8. (previously presented) A traveling wave semiconductor optical modulator for modulating an optical signal with an RF signal, said modulator comprising:

a substrate;

an N-type layer deposited on the substrate;

a semiconductor intrinsic layer deposited on the substrate and in contact with the N-type layer, said intrinsic layer containing an optical waveguide, said intrinsic layer including two-dimensional Bragg diffraction gratings positioned at opposing sides of the waveguide, said diffraction gratings causing the optical signal to propagate down the waveguide in a zig-zag manner so as to increase its propagation length through the waveguide, said first and second diffraction gratings including etched holes that extend in a perpendicular direction to the propagation direction of the optical signal;

a P-type layer deposited on the substrate and in contact with the intrinsic layer; and

a first electrode in electrical contact with the N-type layer and a second electrode in electrical contact with the P-type layer, said first and second electrodes defining a transmission line, said first and second electrodes receiving the RF signal, wherein the first and second diffraction gratings cause the optical signal to have a speed that matches the speed of the RF signal in the transmission line.

9. (original) The modulator according to claim 8 wherein the first and second diffraction gratings are formed by a material different than the material of the intrinsic layer.

10. (original) The modulator according to claim 9 wherein the material different than the intrinsic layer is Quantum dots.

11. (original) The modulator according to claim 8 wherein the first and second diffraction gratings are two-dimensional gratings.

12. (original) A method of modulating an optical signal with an RF signal, said method comprising the steps of:

providing a PIN semiconductor modulator structure, said step of providing the modulator structure including forming first and second Bragg diffraction gratings in an intrinsic layer of the structure where the intrinsic layer contains an optical waveguide, said step further including forming holes in the intrinsic layer that extend in a direction perpendicular to the propagation direction of the optical signal;

propagating the optical signal down the waveguide so that it interacts with the first and second diffraction gratings to cause the optical signal to propagate in a zig-zag manner; and

applying an electric field across the waveguide to modulate the optical signal, where the speed of the electric field along the waveguide is matched to the speed of the optical signal.

13. (original) The method according to claim 12 wherein the step of forming the first and second diffraction gratings include forming the first and second diffraction gratings from a photonic bandgap material.

14. (previously presented) The modulator according to claim 1 wherein the first and second electrodes define a transmission line for the RF signal;

wherein the first and second diffraction gratings slow the optical wave propagating through the optical waveguide to match the speed of the RF signal propagating through the transmission line.

15. (previously presented) The modulator according to claim 1 wherein the first and second diffraction gratings force the optical wave to propagate through the optical waveguide in a zig-zag manner to match the speed of the optical wave through the waveguide to the speed of the RF signal through the electrodes.

16. (previously presented) The modulator according to claim 1 wherein the first and second diffraction gratings serve to increase an effective propagation distance that the optical wave travels from an input of the waveguide to an output of the waveguide.

17. (previously presented) The modulator according to claim 1 wherein the first and second diffraction gratings serve to reduce an effective forward phase velocity of the optical wave.

18. (previously presented) The modulator according to claim 1 wherein the first and second electrodes define a transmission line for the RF signal, wherein one or more characteristics of the transmission line control the speed of the RF signal through the transmission line;

wherein an aspect ratio of the first and second diffraction gratings controls the speed of the optical wave through the waveguide;

wherein the aspect ratio of the first and second diffraction gratings and the one or more characteristics of the transmission line are independently adjustable to match the speed of the optical wave to the speed of the RF signal.

19. (previously presented) The method according to claim 12 wherein the step of forming the first and second Bragg diffraction gratings in the intrinsic layer of the structure comprises the step of:

setting a periodicity of the first and second Bragg diffraction gratings to a level that matches the speed of the optical signal to the speed of the electric field.

20. (previously presented) The method according to claim 12 wherein the RF signal propagates down a transmission line, wherein one or more characteristics of the transmission line control the speed of the electric field, wherein an aspect ratio of the first and second diffraction gratings controls the speed of the optical wave through the waveguide, the method further comprising the step of:

adjusting the aspect ratio of the first and second diffraction gratings and/or one or more of the one or more characteristics of the transmission line to match the speed of the optical wave to speed of the electric field.

* * * * *